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14.4 ppm/.degree. C. Again, the back of the chip is very smooth resulting in a weak mechanical bond and any delamination or cracking of the epoxy between the chip and heat spreader causes a critical reduction in heat transfer from the chip which greatly increases the chip temperature. When this structure is subjected to storage at 130.degree. C. for 1000 hours then thermal cycling of 0 to 100.degree. C. for 1,500 cycles, then -25 to 125.degree. C. for 400 cycles, then -40 to 140.degree. C. for 300 cycles required to prove the reliability of joints between these materials, common epoxies quickly fail (delaminate). The applicants have discovered that with proper treatment a joint between silicon and nickel plated copper of either silicone adhesives (e.g. TC3280G) or flexible-epoxy adhesives (e.g. ABLEBOND 8971 and EG 7655) reliably meet the thermal cycling requirements of this test.

(23)   FIG. 6 shows a direct chip attach module DCAM 300. Flip-chip 302 is attached to a multi-layer fiberglass epoxy substrate 304. Eutectic solder 306 is deposited (by hot air soldering and leveling (HASL), solder-on-chip, solder inject, by transfer from a stainless steel decal) to connect between high temperature solder bumps 308 (e.g. 95/5% Pb/Sn alloy) on the bottom of the chip and copper pads 310 on the top surface of the substrate.

(24)   Copper pads 312 on the carrier substrate are positioned to connect to copper pads on an interconnect structure (organic circuit board as in FIGS. 2 and 5). Solder 314 may be provided on pads 312 for reflow soldered attachment. Alternatively, solder may be provided on the pads of the circuit board. Heat spreader 320 is attached to the back side of chip 302 using an adhesive 322 of flexible-epoxy or more preferably silicon. Improved mechanical strength can be obtained for heat spreaders which extend significantly past the limits of the chip by encapsulating between the heat spreader at 324 and substrate 304 using epoxy adhesives, silicone adhesives, or more preferably flexible-epoxy.

(25)   FIG. 7 shows a computer network embodiment of the information handling

[54] ATTACHING HEAT SINKS DIRECTLY TO FLIP CHIPS AND CERAMIC CHIP CARRIERS

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[73] Assignee: International Business Machines Corporation, Armonk, N.Y.

[21] Appl. No.: 09/094,461

[22] Filed: Jun. 10, 1998

Related U.S. Application Data

[62] Division of application No. 08/672,875, Jun. 28, 1996, Pat. No. 5,847,929

[51] Int. Cl.[7] H01L 21/44

[52] U.S. Cl. 438/107; 438/118; 438/119; 438/122

[58] Field of Search 438/107, 108, 436/118, 119, 122; 361/718, 719

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Primary Examiner—Caridad Everhart
Attorney, Agent, or Firm—Pollock, Vande Sande & Amernick

[57]   ABSTRACT

An aluminum or copper heat sink is attached to a ceramic cap or exposed semiconductor chip using an adhesive of silicon or flexible-epoxy adhesive. The aluminum may be coated by anodizing or Chromate conversion or the copper may be coated with nickel or gold Chromium. Such structures are especially useful for flip chip attachment to flexible or rigid organic circuit boards or modules such as CQFP, CBGA, CCGA, CPGA, TBGA, PBGA, DCAM, MCM-L, and other chip carrier packages in which the back side of chips are connected directly to heat sinks. These adhesive materials withstand wet or dry thermal cycle tests of -65 to 150° C. for 1,000 cycles and 85° C. and 85% relative humidity for 1000 hours while maintaining a tensile strength of at least 500 psi. The adhesive contains materials having high thermal conductivity and a low coefficient of thermal expansion (CTE) in order to provide increased thermal performance and a CTE between that of the silicon metal die and the metal of the heat sink.
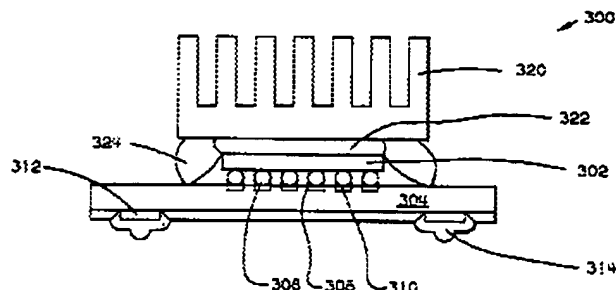
46 Claims, 13 Drawing Sheets

Fig. 6

alumina ceramic;

Claims Text - CLTX (17):
    the method further comprises filling the silicone adhesive with particles of aluminum metal;

Claims Text - CLTX (18):
    the method further comprises selecting a one part silicone adhesive;

Claims Text - CLTX (32):
    the depositing of silicone adhesive includes filling the space around the semiconductor chips between the heat sinks and the wiring surfaces with the silicone adhesive;

Claims Text - CLTX (50):
    wherein depositing the silicone adhesive comprises depositing the adhesive between the heat sink and multiple semiconductor chips.

Claims Text - CLTX (56):
    13. The method according to claim 1, wherein depositing the silicone adhesive comprises depositing the silicone adhesive around the semiconductor chips between the heat sinks and the conformal coating.

Claims Text - CLTX (58):
    filling the silicone adhesive with particles of alumina ceramic.

Claims Text - CLTX (60):
    filling the silicone adhesive with particles of aluminum metal.

Claims Text - CLTX (62):
    selecting a one part silicone adhesive.

Claims Text - CLTX (82):
    30. The method according to claim 1, wherein depositing the silicone adhesive includes filling the space around the semiconductor chip between the heat sink and the wiring surface with the silicone adhesive.

Claims Text - CLTX (106):
    depositing silicone adhesive which is not fully cured between back surfaces of semiconductor chips and the heat sinks at respective windows;

cl. 14

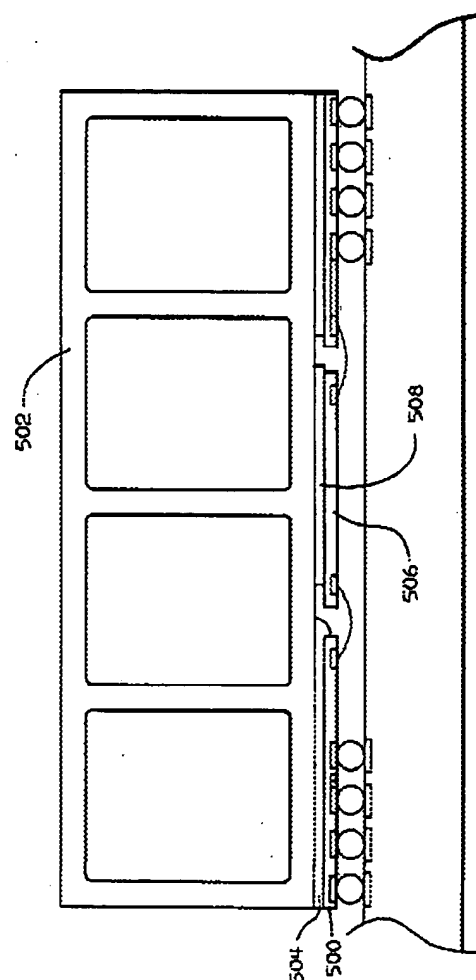U.S. Patent   May 30, 2000   Sheet 11 of 13   6,069,02

FIG. 12

EAST Browser - L12:

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microelectroni
layer of elast
the recess 34.

(7)   The lid 20 is shown in the form of a
cap 50 having a recess 52 adapted to
receive the base 14. The recess 52 is
defined by four side walls 54 and a base
wall 56. The base wall 56 has a central
opening 57 that is adapted to receive
the second layer of elastomer gel 22. The
side walls 54 define a close
tolerance fit with the side walls 36 of the
base 14 and include a continuous
rib 58 that snap fits into a continuous
groove 60 formed in the side walls 36.
It should be understood that the snap fit
rib and groove 58, 60 are shown
simply to illustrate a releasable
connection, and that any suitable form of
releasable connection between the lid 20 and
the base 14 may be utilized.
Further, while it is preferred that the lid
20 be releasably connected to the
base 14, it may be acceptable in some
applications to form a permanent
connection between the lid 20 and the base
14, using any known form of
permanent connection that is appropriate for
the application. While the lid 20
may be of a multi-piece construction and
formed from any suitable materials, it
is preferred that the lid 20 be a unitary
construction molded from a suitable
polymer having low dielectric properties,
such as PEI or PEEK.

(8)   It is preferred that the second layer
of elastomer gel 22 be formed from
a film, sheet, or pad of silicon elastomer
gel or fluoro silicon elastomer gel
having enhanced thermal conductivity, while
also having sufficient structural
stability to prevent undesirable flow of the
gel over an anticipated
temperature range for the particular
application. Experience has shown that
the thermal conductivity of such elastomer
gels is comparatively insensitive to
compression force, thereby providing
acceptable thermal conductivity at their
interfaces with other surfaces without
requiring large compression forces.
This is due, in part, to the inherent
surface wetting capabilities of such
elastomer gels. It is highly preferred that
the thermal conductivity of the
second layer of elastomer gel 22 be enhanced
by using alumina, boron nitride,
or aluminum nitride additives. It is also
highly preferred that these
additives be 60% to 80% by volume of the
elastomer gel to optimize the thermal
conductivity of the second layer of
elastomer gel.

(9)   The electrical contacts 22 are shown

Details Text Image HTML   FULL

US005905638A

United States Patent [19]
MacDonald, Jr. et al.

[11] Patent Number: 5,905,638
[45] Date of Patent: May 18, 1999

[54] METHOD AND APPARATUS FOR
PACKAGING A MICROELECTRONIC
DEVICE WITH AN ELASTOMER GEL

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Gupta, Cary, all of N.C.

[73] Assignee: Ericsson Inc., Research Triangle Park,
N.C.

[21] Appl. No.: 08/993,818

[22] Filed: Dec. 18, 1997

[51] Int. Cl.⁶ H05K 7/10; H05K 7/12

[52] U.S. Cl. .... 361/769; 174/117 A; 174/51 A;
361/767; 361/772; 361/820; 439/66

[58] Field of Search .... 174/217 A, 259,
174/260, 261, 52.4; 206/706, 714, 721,
722, 724, 726; 257/678, 668, 706, 723,
724, 727, 745, 774, 783, 983; 324/755,
756, 765, 158.1; 261/760, 787, 788-771,
774, 776, 779, 783, 807, 809, 83K; 439/117-119;
439/330, 331, 353, 66, 68, 70, 71, 72, 74,
81, 82, 84, 85, 91, 173, 179, 592, 346

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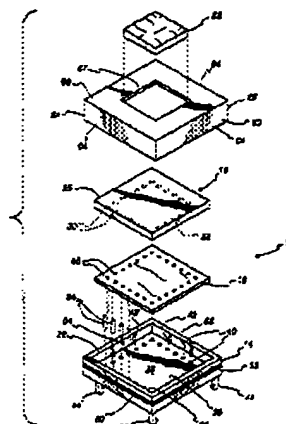
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Primary Examiner—Donald Sparks
Attorney, Agent, or Firm—Wood, Phillips, VanSanten, Clark
& Mortimer

[57]   ABSTRACT

An apparatus and method for packaging a microelectronic
device to be connectable to a distribution circuit. The
apparatus is in the form of a microelectronic package
including a microelectronic device having first and second
oppositely facing surfaces and a plurality of Input/Output
pads on the first surface capable of being electrically inter-
connected to a distribution circuit, a base adapted to support
the microelectronic device in a predetermined operative
relationship to a distribution circuit, and a first layer of
elastomer gel sandwiched between the first surface and the
base. The first surface of the microelectronic device overlaps
the base so as to allow an electrical interconnection through
the base between the microelectronic device and a distribu-
tion circuit.

25 Claims, 2 Drawing Sheets

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